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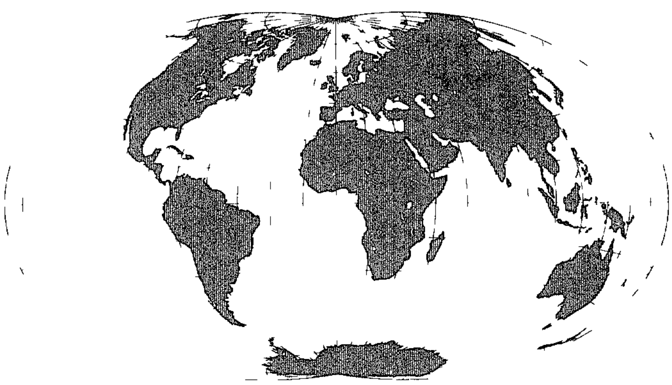
CONSULTING ASSISTANCE ON ECONOMIC REFORM II

DISCUSSION PAPERS



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The objectives of the Consulting Assistance on Economic Reform (CAER II) project are to contribute to broad-based and sustainable economic growth and to improve the policy reform content of USAID assistance activities that aim to strengthen markets in recipient countries Services are provided by the Harvard Institute for International Development (HIID) and its subcontractors It is funded by the U S Agency for International Development, Bureau for Global Programs, Field Support and Research Center for Economic Growth and Agricultural Development, Office of Emerging Markets through Contracts PCE-C-00-95-00015-00 and PCE-Q-00-95-00016-00

Demographic Impacts of the Russian Mortality Crisis

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DEMOGRAPHIC IMPACTS OF THE RUSSIAN MORTALITY CRISIS

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Abstract

DEMOGRAPHIC IMPACTS OF THE RUSSIAN MORTALITY CRISIS

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The Russian mortality crisis of 1990 to 1995 represents the most precipitous decline in national life expectancy ever recorded in the absence of war, repression, famine, or major disease Using standard demographic techniques, we develop a model Russian mortality schedule Applying this schedule, we estimate that there were 1 36 to 1 57 million premature deaths from 1990 to 1995, equivalent to between 14 and 16 percent of all deaths recorded in Russia during that period The deaths were distributed unevenly among the population, with approximately 70 percent occurring among men, and a disproportionate number among working-age people Overall, the 1990-1995 crisis cost between 25 and 34 million person years lived, an order of magnitude greater than the corresponding figure for U S casualties in the Vietnam War and roughly three times the number of forgone person years lived due to AIDS mortality in the U S during 1990-95 The repercussions of the 1990-1995 mortality crisis in Russia and its aftermath will be felt for decades to come We estimate that Russia's population will be about 7 5 million less in 2025 than it would have been had the crisis not occurred The male/female ratio will also be reduced, particularly among the elderly Perhaps the only silver lining of the crisis is that it will dampen the expected increase in Russia's elderly dependency ratio, thereby decreasing the burden on the public pension system

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Introduction

During the three decades from 1959 through 1988, Russian mortality among males followed no clear pattern The expectation of life at birth, e_0, was 63 12 years at the beginning of this period, by 1988, life expectancy had increased only slightly to 64 80 years, with fluctuations taking place in the interim A similar pattern obtained among females, although the eventual rise in life expectancy was marginally greater — 2 82 years versus 1 68 years — from 71 61 years to 74 43 years By comparison, life expectancy rose an average of 7 6 and 10 0 years for males and females, respectively, between 1955-60 and 1985-90 among 11 countries of Southern Europe whose life expectancy in 1955-60 (at 64 3 years for males and 68 5 years for females) was close to that of Russia in 1960 [1] For the world, life expectancy increased by 13 0 years for males and 14 1 years for females during the same period (United Nations, forthcoming 1998)

In the course of the following six years, from 1988 to 1994, life expectancy in Russia declined precipitously This was especially so among males, for whom the increase in mortality was, by any measure, astonishing Their expectation of life at birth decreased by an average of greater than one year of age per year of time passed By 1994, e_0 fell to 57 54 years The decline in e_0 among females, although less dramatic, was still substantial Over that six-year period, their life expectancy had dropped by 3 30 years to 71 13 years Indeed, by 1994 life expectancy in Russia appears to have

[1]The 11 countries are Albania, Bosnia and Herzegovina, Croatia, Greece, Italy, Malta, Portugal, Slovenia, Spain, Macedonia, and Yugoslavia

fallen to its lowest level since the Second World War With respect to male life expectancy, Russia ranked, in 1994, well below all other industrial nations and, even more startling, also below the average level of developing countries (60 6 years in 1990-95)

The causes underlying this sudden and sizable rise in mortality — what has come to be known as the Russian mortality crisis — have yet to be definitively identified However, researchers have speculated on a number of possibilities Elsewhere in this volume, for example, Shkolnikov, Cornia, Leon, and Mesle (1998) conclude that the sharp rise in mortality was either directly or indirectly related to dramatic increases in alcohol consumption and binge drinking (resulting in mortality from alcoholism, alcohol poisoning, heart attacks, accidents, and violent causes) and to maladaption and psychological stress stemming from rather sudden changes in economic and social conditions (e g , resulting from "shock therapy" economic reforms) [2]

This article has two main objectives First, we seek to estimate the number of premature deaths that took place in the first half of the current decade due to the mortality crisis In other words, we compute the difference between the number of deaths actually observed during the period 1990 through 1995 and the deaths that would have occurred had mortality rates remained on a stable path The overall change in the number of deaths per year is an ill-founded and potentially misleading

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[2]Shkolnikov, Vladimir M , Andrea G Cornia, David A Leon, and France Mesle, "Causes of the Russian Mortality Crisis Evidence and Interpretations," this issue

measure of the magnitude of the crisis since the number of deaths would be expected to change in any case due to changes in the age distribution and long-term trends in age-specific mortality rates We address the notion of prematurity by examining the number of person-years lost by those who died during the period of the mortality crisis Thus we analyze two dimensions of the short-term losses incurred as a result of the crisis the sheer "excess" of deaths that took place between 1990 and 1995 and the "untimeliness" of those deaths, relating to the fact that these excess deaths occurred in many instances long before they would have had the mortality crisis never transpired The person-years lost can be decomposed into the number of premature deaths and the expectation of life at the average age of premature death

Second, we project the size and structure of the Russian population three decades into the future, to the year 2025, under a variety of demographic scenarios [3] The purpose of this second exercise is to determine the longer-term consequences of the mortality crisis, as measured by its impact on three key indicators of Russian demography -- population size, age structure, and sex ratio -- a fair distance into the future We limit our projections to the year 2025 because our analyses show that estimates of population size and structure become highly uncertain beyond that year

At the outset, we note that the Russian mortality crisis reached its apex in 1994 Life expectancy rebounded somewhat from 1995 through 1997, gaining 2 5 years among males and 2 0 years among females Our analysis is consistent with this

[3]To project the population, we use ABACUS, which is the PC version of the United Nations Computer Population Projection Program

increase insofar as life expectancy has reached a plateau for this quinquennial period It is also consistent with the latest demographic projections by Goskomstat, Russia's national statistical agency These projections reflect no further improvement in Russian mortality for the remainder of this decade

Russian demographic data are generally regarded to be of high quality The data on Russian mortality analyzed here are based on vital registration statistics published in the Demographic Yearbook of Russia (1993, 1995, and 1996), and Avdeev and Monnier 1996 Studies of death registration in Russia reveal high levels of completeness Nearly 95 percent of all deaths in Russia since the 1980s have been certified by doctors, with the rest being certified by other trained medical personnel (Leon, Chenet, Shkolnikov, Zakharov, Shapiro, Rakhmanova, Vassin and McKee 1997)

There are two known weaknesses involving Russian mortality data The first involves age heaping and age overstatement among the elderly The second concerns the official Russian definition of a live birth, which was much more restrictive than the international standard prior to 1993 In particular, the Russian requirement for classifying a birth as "live" was that the gestation period exceed 28 weeks, the birth survived at least one week, weigh at least one kilogram, and be at least 35 centimeters long By contrast, the international standard is essentially "any evidence of life," irrespective of the above factors Therefore, "true" infant mortality rates prior to 1993 are believed to be 25 percent higher than reported rates [4] Our analyses incorporate this correction factor, which is decreased to 15 per cent in 1993, 10 per cent in 1994, and discontinued from 1995 to account for a gradual introduction of the WHO-recommended definition of a live birth Neither of these weaknesses has a signficant effect on life expectancy at birth, which is the key statistical series that anchors the analyses reported below (Shkolnikov, Mesle, and Vallin 1995, and Anderson and Silver 1997)

IMMEDIATE DEMOGRAPHIC IMPLICATIONS

Our strategy for assessing the short-term impact of the Russian mortality crisis is to compare actual Russian mortality during 1990-1995 with estimates of Russian mortality that would have obtained in the absence of the mortality crisis [5] We construct estimates of counterfactual Russian mortality by selecting a series of substitute mortality schedules that would plausibly have been realized in the absence of the crisis

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[4] Anderson, Barbara and Brian Silver 1989 Infant mortality in the Soviet Union regional differences and measurement issues *Population and Development Review*, Vol 12, No 4, pp 705-738, Mesle, France, Vladimir M Shkolnikov, Veronique Hertrich and Jacques Vallin *Tendances récentes de la mortalité par cause en Russie 1965-1994* Paris INED Serie Donnees Statistiques No 2

[5] Along with Pia Malaney, we also explored an alternative approach to estimating the number of premature deaths This approach involved extrapolating 1959-85 time series of age-specific death rates and comparing the extrapolations with observed age-specific death rates This approach yields similar results for the period 1990-95 to those that we report here However, this method is not appropriate for long-term population projections as it eventually results in age patterns of mortality that deviate considerably from well-established historical standards

To obtain a substitute series we have to decide upon the domain of years from which we will extrapolate the posited mortality schedules We propose two alternatives In both cases, the last year that we include as the basis for projecting mortality in 1990 through 1995 is 1985 We omit the mortality experience of the late 1980s because it is during that period that President Gorbachev's anti-alcohol policy was in effect [6] This policy served ultimately to raise life expectancy substantially, at a rate well beyond that found in the two decades prior to that time Incorporating this brief and unusual period in our projections would cause us to overestimate the speed with which mortality could be expected to improve

The first proposed alternative mortality schedules pertaining to the 1990-1995 period are based on expectations of life at birth between 1959 and 1985 [7] Among males, e_0 decreased from 63 12 years in 1959 to 62 73 years in 1985 Among females, e_0 increased from 71 61 years to 73 31 years during this period Thus, life expectancy rose by an average of 0 07 years of age per year of time for females, but declined by an

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[6]Gorbachev's anti-alcohol campaign ran from June 1985 through the end of 1987 The campaign involved cutting back sales of alcohol in state stores, increasing retail prices, curtailing the illegal production of home-brewed spirits (*samogon*), expanding the network of specialized medical establishments for compulsory treatment of alcoholism, and a massive propaganda campaign From 1984 to 1987, the number of stores selling wine and spirits was reduced by 80 per cent, eight brand new Czechoslovak-made beer breweries were razed, and vineyard acreage was cut by 30 percent As a result, estimated per capita consumption decreased by 25 percent, reflecting a more than 50 percent drop in official alcohol sales, which was partially offset by a doubling of samogon production (Shkolnokov, Vladimir M and Alexander Nemtsov 1997)

[7]Life expectancies are drawn from A Avdeev and A Monnier (1996)

average of 0 02 year for males

The second proposed mortality schedule is based on life expectancies observed during the more restricted range of years, 1980 through 1985 Among males, e_0 was 61 46 years in 1980 and among females, 72 85 years Thus, by focusing on this more narrow domain of years, we obtain a more "optimistic" scenario in which mortality is posited to improve at a faster pace than that found in the previous scenario In particular, during this period e_0 increased among females by an average of 0 09 year of age per year of time and among males, by an average of 0 25 year

Figure 1 displays the two proposed projection schemes for males and females, respectively In the first scenario in which mortality is projected for the years 1990 through 1995 from the mortality experience of 1959 through 1985, e_0 among males is estimated to be 64 12 years by 1995 The second scenario, for which the basis for projection is the period 1980 through 1985, implies an e_0 in 1995 of 65 73 years These life expectancies are in stark contrast to the observed 1995 e_0 of 58 25 years

Among females, the first scenario results in an e_0 of 74 86 years in 1995, the corresponding e_0 associated with the second scenario is 75 03 years These life expectancies, too, are considerably higher than the observed level of 71 64 years

In order to construct estimates of premature mortality and to project various aspects of the size and composition of the Russian population, it is necessary to link each of the foregoing life expectancies to a schedule of age-specific probabilities of dying We do this using actual Russian age-specific probabilities of dying in 1988-89, separately for males and females, as underlying reference distributions These distributions are rescaled using the MATCH procedure of the MortPak-Lite software package[8] so that they have values of life expectancy at birth corresponding to each hypothetical scenario Applying these surival ratios to the 1990 distribution of population by age and sex yields age-sex-specific estimates of hypothetical deaths during the period 1990-95 The differences between the actual and hypothetical deaths are estimates of premature deaths by age and sex

Our use of actual Russian age-specific probabilities of dying as a reference distribution deserves comment insofar as it deviates from demographers' standard reliance on model life tables Nine families of model life tables are widely used for the general purpose of mortality projection four families from the Coale-Demeny system and five from the United Nations system However, none of these is appropriate in the present application because the Russian mortality pattern differs substantially from the patterns embodied in these families of life tables

Table 1 illustrates the unusual age pattern of Russian male mortality It reveals a departure of observed age-specific mortality rates in 1990-95 from all nine available families of model life tables More specifically, the Russian pattern embodies relatively low mortality in childhood and adolescence, and moderately high death rates for ages

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[8] The Coale-Demeny regression equations (Coale, A and P Demeny 1966 *Regional Model Life Tables and Stable Populations* Princeton Princeton University Press, p 21) are used with an iterative procedure (United Nations 1982 *Model Life Tables for Developing Countries* Sales No E 81 XIII 7, pp 22-23) to find the life table corresponding to a given level of mortality See also United Nations 1988 MortPak Lite *The United Nations Software Package for Mortality Measurement* Sales No E 88 XIII 2, pp 86-91

above 70 To illustrate, if all the age-specific probabilities of dying were in accordance with the observed infant mortality rate, Russian male life expectancy would be in the range of 69 6-78 3 years, depending on the model life table, far above the observed level of 60 6 years By contrast, from age 25 on up, Russian male mortality exceeds all model levels For example, the actual Russian probability of dying at ages 50-54 corresponds to a life expectancy at birth of just 33 6 years in the South Coale-Demeny model, 27 years less than actually observed Relative to the model distributions, Russian females also exhibit relatively low child and adolescent mortality and relatively high adult mortality, although the effects are less pronounced than for males

Given that none of the model life tables adequately describes Russian mortality patterns we proceed by using the observed Russian sex-specific mortality schedules in 1988-89 (and, 1990-95, for the long-term projections below) as standards

For both males and for females, the two life expectancy scenarios yield qualitatively similar results Among males, under the first scenario, we find that there would have been 4 07 million deaths during the 1990-1995 period in contrast to the actual number of 5 01 million deaths Thus, under the assumptions implicit in the first scenario, we compute that 18 7 percent of the deaths that took place were premature (940,000) The number of premature deaths was greater, of course, in the second scenario, due to the fact that its mortality assumptions are more optimistic In this scenario, there would have been 3 89 million deaths, thus implying that 22 3 percent of the observed deaths were premature (1,120,000) [9]

Figure 2a plots the distribution of premature deaths by age under the two mortality scenarios The figure shows that the proportion of deaths that are judged to be premature, regardless of which scenario is chosen, is not uniform across age For example, 41 5 percent of the 295 thousand observed deaths in the age group 40 through 44 are estimated to be premature versus a more modest 10 3 percent of the 390 thousand observed deaths to individuals aged 70 through 74 [10]

Among females, as one can see in Figure 2b, the two scenarios give rise to virtually identical results This is a consequence of the fact that the trends over the two time periods studied — 1959 through 1985 and 1980 through 1985 — are quite similar

Under the first scenario, we find that there would have been 4 47 million female deaths rather than the 4 89 million deaths observed Therefore, the proportion of deaths that are estimated to have been premature is 8 3 percent (420,000) This proportion is altered only slightly in the second scenario, in which 4 44 million deaths are estimated to occur The corresponding figure is 9 1 percent (450,000)

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[9]Relative to an unspecified Western mortality distribution, Vishnevsky and Shkolnikov (1997a) construct a considerably higher estimate of 3 1 million excess male deaths from 1991 to 1995 (representing an astonishingly high 58 percent of all deaths in those years) In contrast, Shkolnikov 1997b reports an estimate of 2 3 million excess deaths among men and women during the six years, 1990 through 1995 The method used to construct this estimate is not presented in detail

[10]That the proportion of premature deaths is negative at some of the early ages among males is a result of the fact that observed mortality rates at these ages were actually improving significantly over time The observed improvement in these rates was greater than that implied by the projected fitted life tables that we adopted over the period 1990 through 1995

Here, too, we may note that the proportion of observed deaths that may be considered to be premature varies considerably over age According to the second scenario, among the 88,900 observed deaths occurring to 40 through 44 year-olds, we find that 33 1 percent are estimated to be premature In contrast, far fewer — 7 5 percent — of the 538,000 observed deaths among 70 through 74 year-olds are classified as premature

A rather striking feature of Figure 2a is the depiction of a substantial "negative" number of premature deaths among young males, that is, infants and children This is due to the fact that age-specific mortality rates for young males actually improved during the period 1990-1995, in contrast to the deterioration of mortality rates at higher ages [11] This result is especially curious in light of the absence of a similar trend among young females (see Figure 2b)

Taken together, the results in Figures 2a and 2b suggest that the distribution of mortality by age and gender shifted somewhat with the onset of the mortality crisis (in contrast to our finding of its relative stability throughout the decades leading up to the crisis) [12]

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[11] It is well established in the demographic literature on age patterns of mortality, that mortality rates at all ages tend to covary negatively with life expectancy Although our results are generally consistent with this expectation, we do note one deviation with regard to the divergent mortality trends among Russian male children during 1990-1995

[12] Our examination of the evidence does not allow us to rule out the possibility that the age component of this shift is associated with movements in the total fertility rate, which declined from 2 25 to 1 22 from 1987 to 1997 Indeed, the correlation between the total fertility rate and the infant mortality rate is 0 68 over the period 1960-

Lost Person-Years Lived

While we have now estimated the number of deaths that occurred prematurely in the 1990-1995 period, we do not as yet have an idea of the number of person-years lost due to the mortality crisis A certain number of persons may have died prematurely, but how long would they have lived in the absence of the crisis? Clearly, a given level of premature mortality represents a greater demographic loss if it occurs among 30 year olds than if it occurs among 75 year olds

Estimating the loss of person-years lived requires that we select a mortality schedule that would have been followed by those who died prematurely had the mortality crisis never existed

One possible assumption is that those who died prematurely would have adhered to the same mortality pattern as those who did not die in this period Another approach is to posit that the health of those who died prematurely was inferior to that of the remainder of the population (that is, the mortality schedule applicable to those who died prematurely was substantially worse than that of those who lived through the crisis) How much higher their underlying mortality rates were is open to debate In the

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1995 It is also worth noting that the relative improvement in male child mortality coincides with an unusual increase in the male/female sex ratio at birth from 1 051 during 1959-1989 to 1 061 during 1990-1995 Thus, the comparison of Figures 2a and 2b and this result about the sex ratio at birth are consistent with the possible emergence of a modest son preference in Russia However, insofar as previous literature does not allude to the existence of son preference in Russia, much further research would be required to evaluate this hypothesis as well as other possible explanations, such as imperfect data following analysis, we speculate for argument's sake that the mortality rates of those who died prematurely in the absence of the crisis would have been (a) equal to the mortality rates associated with those who lived through the crisis, or (b) twice the level of those rates We calculate the estimated person-years lost under both assumptions [13] (See Alter and Riley 1989, Kannisto 1991, Lam and Smouse 1990, Vaupel 1988, and Weiss 1990, for useful discussions of the distribution of frailty and its demographic implications)

In Figure 3 we graph the number of person-years lost for those who died in each age group above age 15 under the hypothesis of homogeneity of frailty [14] Assuming that those who died prematurely were no different with respect to their underlying mortality schedules than those who did not die prematurely, among males, we find that the number of person-years lost was highest among those who died prematurely in the age groups 35 through 44 For each of those groups, more than three million person-years were lost due to the crisis A total of 24 6 million person-years were lost among males

Adopting the more conservative estimation approach — namely that those who

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[13]Lost person years lived are estimated in three steps First, we use the age-specific death rates in each scenario to construct a standard life table schedule of person years lived Second, we calculate the difference in person years lived between the two scenarios Third, we scale the results to take account of the number of premature deaths We account for the possibility of greater frailty among those who died prematurely by constructing a life table based on age-specific death rates that are twice the levels of the 1988-1989 reference distribution

[14]We focus on ages 15 and over because this is the age range in which we have the greatest confidence in our estimates of premature mortality

died prematurely suffered twice the mortality rates of those who did not die prematurely — we find that the number of person-years lost declines to 17 6 million Note that although we doubled the mortality rates, the estimate of person-years lost declined by 28 percent The fact that person-years lost declined by far less than half when mortality rates were doubled is due to the nonlinearity of the relationship between age-specific death rates and the survivorship function

Among females, under either scenario we find that the number of person-years lost, while considerable, is far less than that among males The age distribution of person-years lost appears to be somewhat older, with peaks occurring in the ages 40 through 59 In each of the five-year age groups falling within that range, approximately one million person-years were estimated to have been lost, under the assumption of homogeneity of frailty among those who died prematurely and those who did not In total, under this scenario we estimate that 9 6 million person-years were lost among females Invoking the more conservative approach, we find that the estimate of person-years lost is reduced by 23 percent, to 7 4 million

Regardless of which assumption we make about the relative mortality of those who died prematurely during the crisis, we find that the total number of person-years lost among females is approximately 40 percent of that for males — 39 percent assuming equal mortality rates among those who did and did not die prematurely and 42 percent assuming twice the mortality rates of those who died prematurely versus those who did not

Overall, the 1990-1995 crisis cost between 25 and 34 million person years lived This is roughly 10 times the number of lost person years lived by the 55,000 Americans who died during the entire Vietnam War It is also about three times the number of lost person years lived by the 240,000 Americans who died of AIDS during the years 1990-95

Long-term Demographic Implications

To augment our picture of the demographic implications of the Russian mortality crisis, we focus now upon selected long-term consequences In particular, we examine the impact that the crisis will have had by the year 2025, some 30 or so years after the crisis' end, on (1) population size, (2) age distribution and dependency ratio, and (3) sex ratio

We examine three scenarios that underlie the demographic projections that yield sex-specific age distributions of the population in 2025 These scenarios correspond to three different mortality trajectories, but assume the same fertility and migration patterns over time for each mortality trajectory All three scenarios assume constant fertility at the average level found between 1990 and 1995, namely a total fertility rate of 1 5 children per woman [15]

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[15]Our migration assumptions are as follows We adopted the high and low scenarios of annual net migration for three periods (1995-1999, 2005-2009 and 2020-2024) from those presented in E Andreev, S Scherbov, and F Willekens, *The population of Russia fewer and older*, Faculty of Spatial Sciences, University of Groningen, 1997, p 55, which closely correspond to the projections of Goskomstat Russia We then interpolated net migration for the remaining 5-year intervals, which yielded a virtually linear, decreasing trend from 1,970 thousand in 1995-2000 to 661 thousand in 2020-2025 The partition of the projected net migration into immigration

Our strategy is to construct one set of projections whose starting point is 1995 and another set that begins in 1990 The projections starting in 1995 use the actual population age distribution in 1995 and the actual 1995 mortality schedule as initial values In the mortality projection procedure we adopt, the pace of future mortality improvements is based on the initial level of mortality Our population projections are influenced by the 1990-1995 mortality crisis through its effect on (a) the 1995 population size and age structure, and (b) the level of mortality in 1995 and its future trajectory The projections that begin in 1990 ignore the mortality crisis, that is, they are based on a population pyramid and mortality schedule that predate the crisis Thus, the resulting 2025 population will differ from the 1995-based projections because of the initial differences in population size and age structure and the differences in mortality level and the subsequent trajectory based on that initial mortality level

Three models for mortality improvement (fast rise, middle rise and slow rise) were developed by the United Nations on the basis of historical patterns (United Nations, 1998) They assume that improvement becomes slower is life expectancy rises The highest life expectancy at birth allowed in these models is 87 5 years for females and 82 5 years for males For instance, the model assumes that male life

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and emigration was carried out assuming that the ratio of immigration to emigration, which had drastically increased from a stable level of 1 2 1 for the 1980s to 1 7 1 in 1990-1995, will decrease linearly to return to its prior level after 2015 The age structure of immigrants is very different from the age structure of emigrants, but both are relatively stable over time The projected levels of immigration and emigration were distributed according to their respective age compositions, the balance of immigrants and emigrants in each age group yields the projected age-specific level of net migration expectancy at birth increases by 2 5 years every quinquennium in the fast and middle scenarios (2 0 years in the slow scenario) until it reaches 60 years and that the quinquennial gain is then gradually reduced to 0 3-0 5 year

We apply these three models to two sets of assumptions with respect to life expectancy in 1990-95 The resulting assumptions regarding life expectancy for each quinquennium are reported in Table 2 These figures are used to adjust the 1990-95 sex-specific age pattern of mortality to construct the mortality rates used in our projection exercises

We have adopted the model for mortality improvement proposed by the United Nations The UN method of projection of life expectancy depends upon the initial value of e_0, the higher that value, the lower the projected increases in e_0 per each succeeding quinquennial period The mortality scenarios for males and females are illustrated in Table 2 The "no crisis" projections, as we shall call the projections that begin prior to the mortality crisis and follow the middle path of mortality improvement indicated by the United Nations, show that among Russian males, life expectancy increases form a level of 64 8 years in the quinquennial period 1990 to 1995 to 72 7 years in the period 2020 to 2025 Among females, the 1990 middle path projections posit a rise in e_0 from 74 9 years to 80 5 years

What we refer to as the "crisis" projections, begin, naturally, from a considerably worse level of mortality As shown in Table 2, in 1995 to 2000, the expectation of life at birth among males is estimated in the middle path scenario to be 59 5 By 2020 to 2025, e_0 rises to 69 0 years Among females, we see that life expectancy begins at

72 4 years for the middle path scenario and improves to 78 1 years

As above, our strategy for assessing the 30-year implications of the 1990-1995 mortality crisis is to compare two projected populations in the year 2025 The first is projected using 1990 as a starting point, while the second uses 1995 In each of these, we examine not only the middle path assumptions for mortality improvement but the fast and slow path assumptions as well However, since the results are relatively invariant to these assumptions (with the exception of population size), we confine our discussion of results to those stemming from the "crisis" and "no crisis" middle path projections

Impact on Overall Population Size and Age Structure

Figures 4a and 4b display the age distributions of Russian males and females, respectively, in the year 2025 for the "no crisis" and "crisis" scenarios — that is, the scenario in which the mortality crisis is assumed never to have taken place and that in which its effects are incorporated into the projection The "crisis" projection yields a male population in 2025 of 65 62 million, down 5 5 percent from 69 44 million in 1990 If the mortality crisis had never taken place, we project, under the "no crisis" scenario, that the population would have reached a level of 70 45 million, that is, 1 5 percent higher

Among females, in the "crisis" projection, the effect of the mortality crisis is estimated to result in a population decrease of 5 3 percent, from 78 85 million to 74 68 million Had the mortality crisis not occurred, the population is projected to have decreased only modestly, by 1 9 percent, to 77 33 million

Comparing the two projected populations, we find that there are 6 9 percent fewer males in 2025 than there would have been had the crisis not taken place This percentage varies substantially, and systematically, by age As seen in Figure 5, the proportion of "missing" males increases from under two percent for the age groups under age 25 to some 31 1 percent for the oldest age group examined, those age 80 years old and above

Among females, the effect of the mortality crisis is approximately half that among males There are 3 4 percent missing females in 2025 as a result of the crisis Figure 5 reveals that here, too, the effect varies considerably and in consistent fashion across age The proportion of missing females is less than two percent among all age groups under 55 years old Thereafter, the proportion increases rapidly to 19 3 percent among women exceeding 80 years of age

As mentioned above, the total population size estimated for the year 2025 is highly sensitive to the speed with which mortality is assumed to decline For example, the 2025 male population under the "crisis" slow mortality improvement scenario is estimated to be 64 88 million versus 70 03 million under the "no crisis" slow projection Among females, the corresponding total population sizes are 75 28 million and 76 54 million The projected male population in 2025 under the "crisis" fast mortality improvement scenario is estimated to be 66 23 million versus 71 39 million under the "no crisis" fast projection The corresponding total population sizes among females are 75 28 million and 77 89 million Despite the fact that the estimated population size in

2025 varies according to the speed of mortality decline that is assumed, the impact of the mortality crisis on overall population size appears to be rather insensitive to this assumption By positing slow mortality improvement over the 30-year time period, we obtain estimates of 7 3 percent and 3 4 percent decreases in population size among males and females, respectively, due to the existence of the mortality crisis and estimates of 7 2 percent and 3 4 percent when assuming fast mortality improvement — decreases virtually identical to those inferred from the fast mortality decline scenarios (once again, 6 9 percent and 3 4 percent, respectively) Table 3 summarizes these findings and highlights the fact that the effect of the mortality crisis on population size exceeds the number of premature deaths between 1990 and 1995 By elevating Russian mortality rates during 1990-1995 and thereby establishing higher levels of mortality going forward, the crisis has a continuing negative effect on population size This (assumed) inertia in mortality rates, coupled with decreased births resulting from a smaller population in the reproductive ages, results in there being approximately 7 5 million fewer Russians in 2025, roughly five times larger than the number of premature deaths during 1990-95

Impact on the Dependency Ratio

The overall dependency ratio can be decomposed into two parts, childhood dependency and elderly dependency The former measure is defined as the number of children aged zero through 14 per 1,000 individuals aged 15 through 59 for males and per 1,000 individuals aged 15 through 54 for females The sex differences in the age limit in the denominator are due to sex differences in the typical age of retirement Similarly, the latter measure is defined as the number of elderly aged 60 and above per 1,000 individuals aged 15 through 59 for males and the number of elderly aged 55 and above per 1,000 individuals aged 15 through 54 for females

For males, as exhibited in Figure 6a, the overall dependency ratio — according to the "crisis" middle path projection — is estimated to be 574 per 1,000 in 2025 This breaks down into a childhood dependency ratio of 252 per 1,000 and an elderly dependency ratio of 321 per 1,000 Had the mortality crisis not existed, according to the "no crisis" middle path projection, we would have seen an overall dependency ratio of 621 per 1,000 The corresponding decomposed ratios are 245 per 1,000 and 375 per 1,000, respectively Thus, the overall dependency is estimated to be 7 6 percent less than it would have been in 2025 had the crisis not existed The individual effects on the childhood and elderly dependency ratios are very different, however The elderly dependency ratio is one-seventh less (14 4%) in 2025 due to the effects of the mortality crisis In contrast, the childhood dependency ratio is actually 2 9 percent greater as a result of the crisis (since there will be so many fewer adults)

In Figure 6b, we see that the effects of the mortality crisis on the female dependency ratio are similar to those for males, but are of lesser magnitude The overall dependency ratio in the year 2025 was reduced by the mortality crisis from 1,000 to 954 per 1,000, or by 4 6 percent Once again, the effects are distributed in different fashion for the childhood and elderly dependency ratios The former remains constant at 262 per 1,000, while the latter decreases by 6 2 percent, from 738 to 692 per 1,000

In sum, the mortality crisis will dampen the expected increase in Russia's elderly dependency ratio, maintaining the ratio at a nearly constant level through the first decade of the next century (See Figure 6c)

Impact on the Sex Ratio

The mortality crisis of 1990-1995 clearly had ramifications with respect to the balance of the sexes in Russia that will reverberate for decades to come As shown in Figure 7, the overall sex ratio in 1990 was 88 1 males per 100 females Under the "crisis" middle path scenario — that is, acknowledging the impact of the mortality crisis — we find that the sex ratio by 2025 will have remained virtually unchanged, at 87 9 per 100 However, had the crisis not taken place, we estimate that the sex ratio would have increased to 91 1 per 100 Thus, the overall sex ratio in 2025 is anticipated to be 3 6 percent less than it would have been in the absence of the mortality crisis

The effect is more dramatic when we focus solely upon the sex ratio of the elderly, that is, individuals aged 60 years and above The elderly sex ratio in 2025 is projected to be 61 3 males per 100 females, under the "crisis" middle path scenario In contrast, we estimate that the corresponding sex ratio would have been 68 5 per 100 had the crisis never occurred Therefore, the sex ratio among the elderly is 10 5 percent less than it might have been in the absence of the mortality crisis

Table 4 reports estimated age-specific sex ratios during 1990-2025 The estimates in the first panel ignore the mortality crisis, while those in the second panel incorporate its effects The figures show that the impact of the crisis is to depress the sex ratio, mainly because the crisis disproportionately affected males However, the effect is quite modest, suggesting the crisis will not have an appreciable influence on age matching in the Russian marriage market

Policy Implications of the Crisis

This paper has identified three main demographic consequences of the 1990-95 Russian mortality crisis slower growth of Russia's overall population, disproportionately slower growth of Russia's working age population through 2025, and a rising ratio of females to males, especially at the older ages

These demographic changes are sizable and have potentially important social and economic implications for Russia On the social side, the demographic crisis will serve to undermine the stability and structure of the Russian family, leaving many children to spend more of their youth growing up with but one parent Given the extensive international evidence linking single parenthood and poverty (see, e g , Smeeding and Torrey, 1988), Russia's current demographic crisis may be expected to contribute to increased poverty and thereby impair the future economic prospects of today's youth The gender selectivity of the crisis also suggests a sharp increase in the proportion of lone elderly women Insofar as the mortality crisis is also accompanied by declining fertility, private sources of elder care, companionship, and economic support will diminish in the future, potentially imposing an additional burden on the state

In economic terms, the crisis suggests a loss of wealth associated with the loss of human capital embodied in those who died prematurely It also suggests that the Russian economy will grow more slowly in the future, for two reasons (Bloom and Malaney, 1998) First, to the extent the crisis slows the growth rate of the working age population (relative to that of the dependent population), it will slow the growth of the productive capacity of the economy per capita Second, recent research suggests that life expectancy is a powerful predictor of subsequent economic growth, presumably because a longer-lived population is healthier and more productive, and has greater incentives to undertake investments in human capital Economic inequality can also be expected to rise since there is some evidence that the increase in death rates is disproportionately selective of the less educated (Shkolnikov et al , 1998) On the other hand, the mortality crisis will tend to diminish the fiscal burden that population aging would otherwise impose on the social pension system

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Expectation of Life among Russian Males and Females, 1959-1995, Incorporating Two Mortality Scenarios for 1990-1995

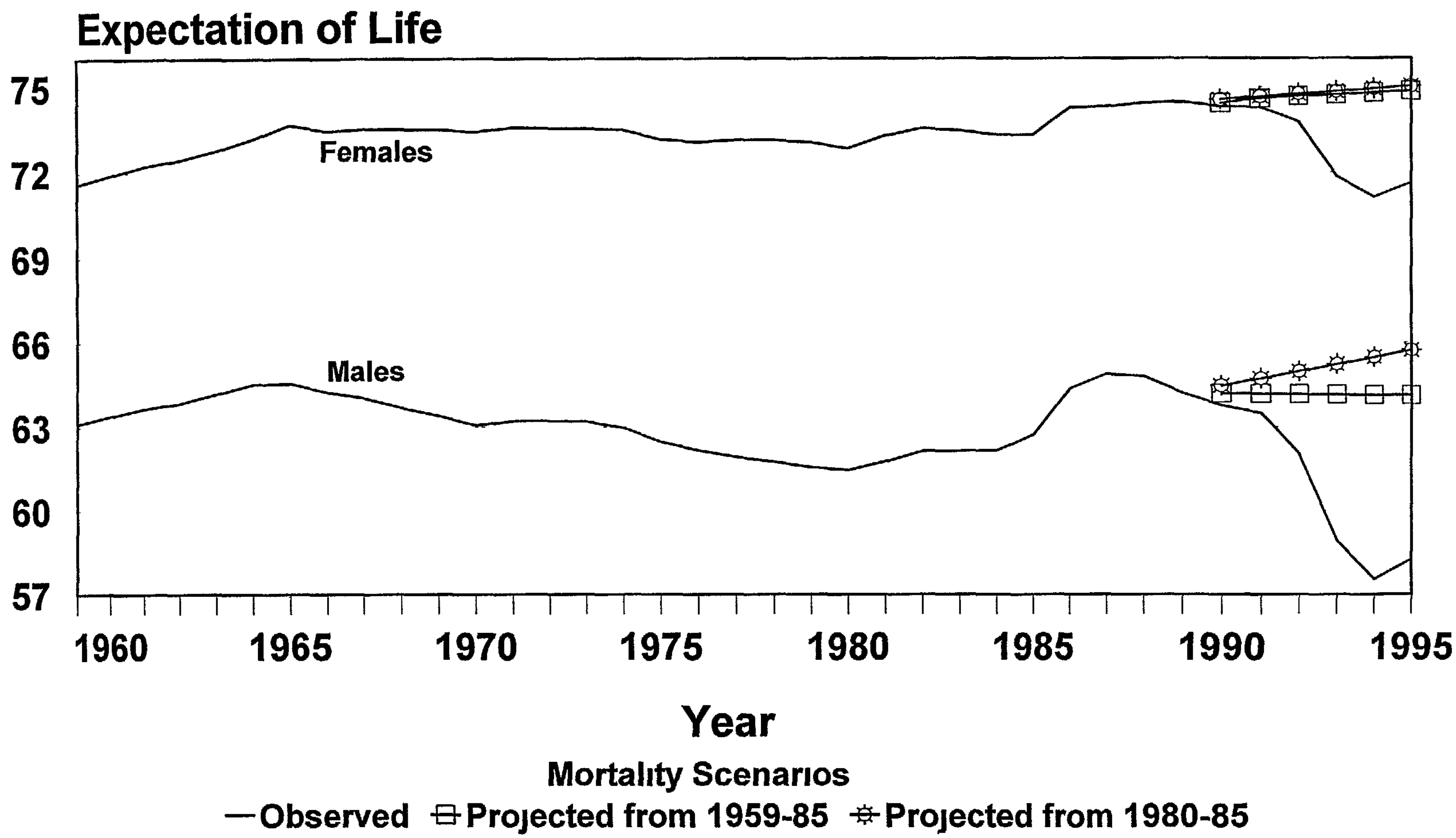

Figure 1

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Premature Male Deaths, by Age, 1990-1995, under Two Mortality Scenarios

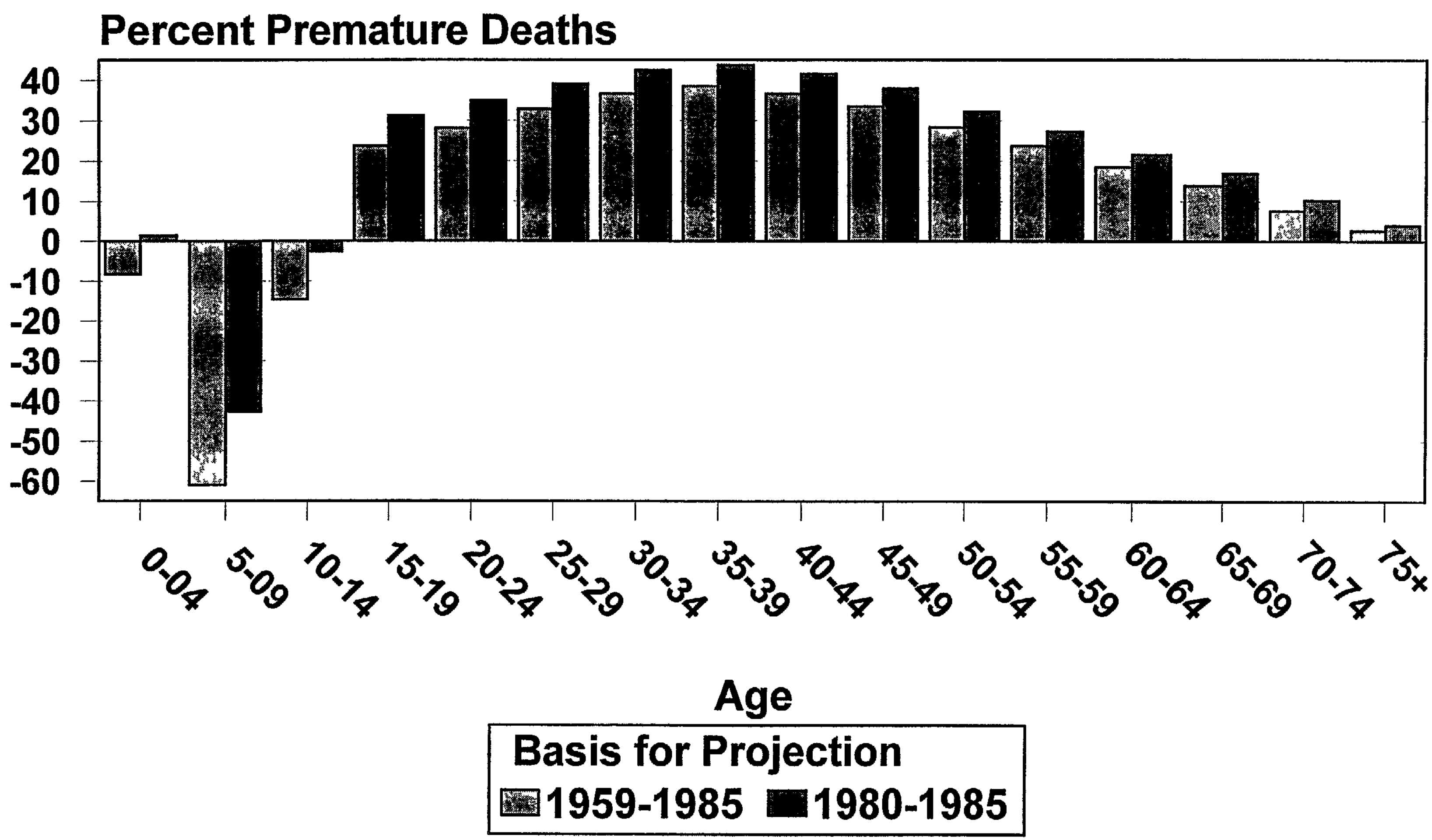


Figure 2a

Premature Female Deaths, by Age, 1990-1995, under Two Mortality Scenarios

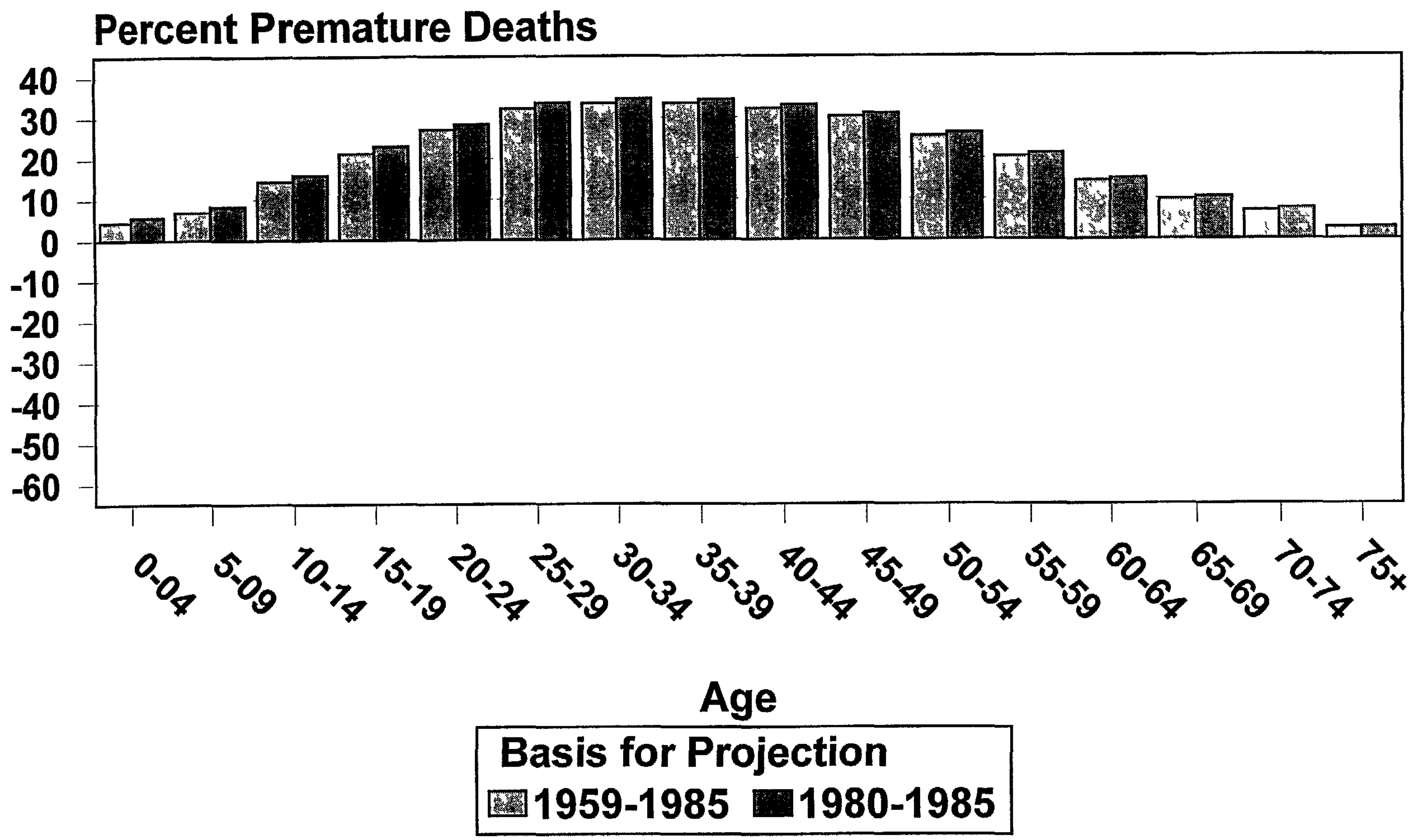


Figure 2b

30

Person-Years Lived Lost the among Russian Males and Females who Prematurely Died Due to the Mortality Crisis, 1990-1995, under Two Assumed Mortality Regimes

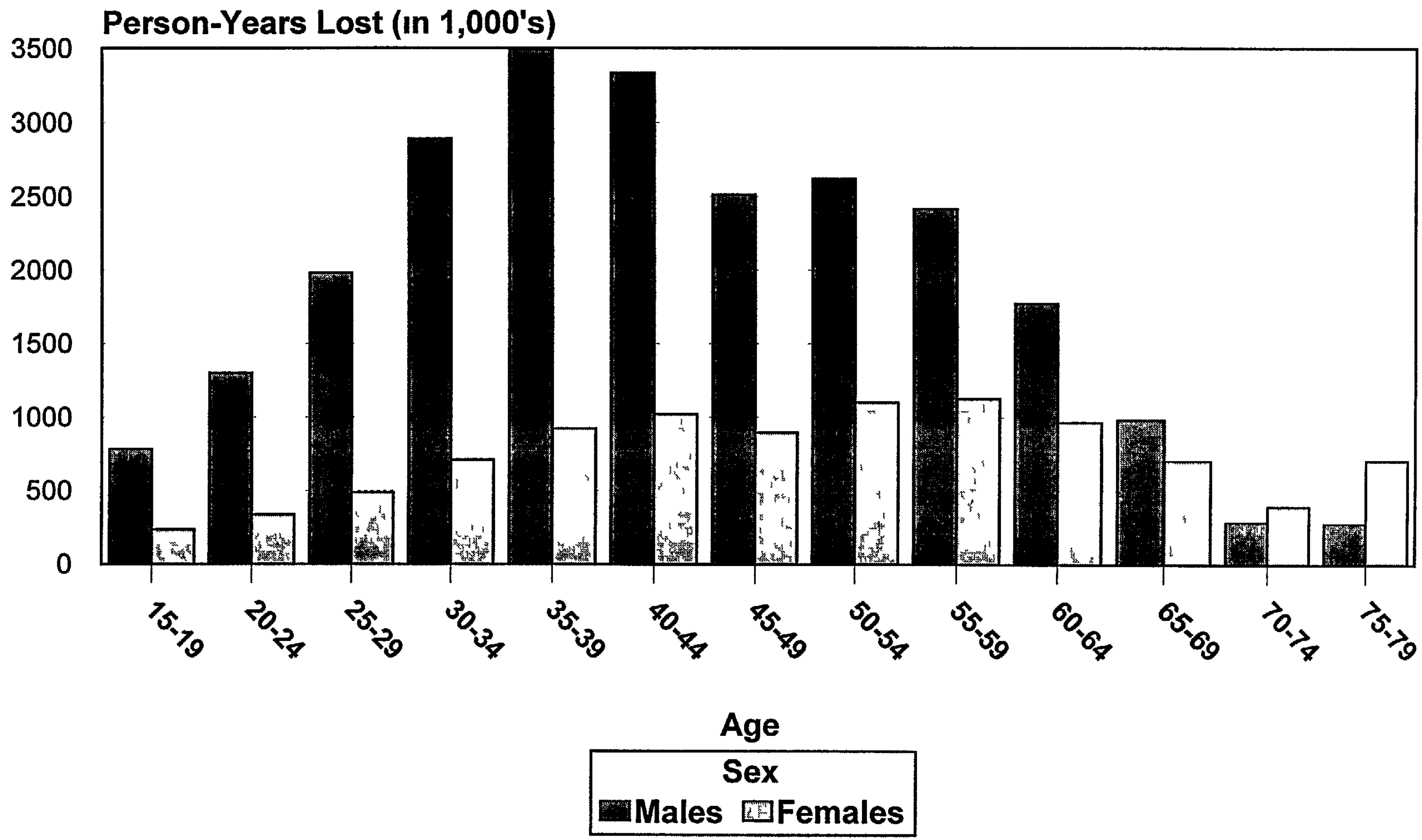
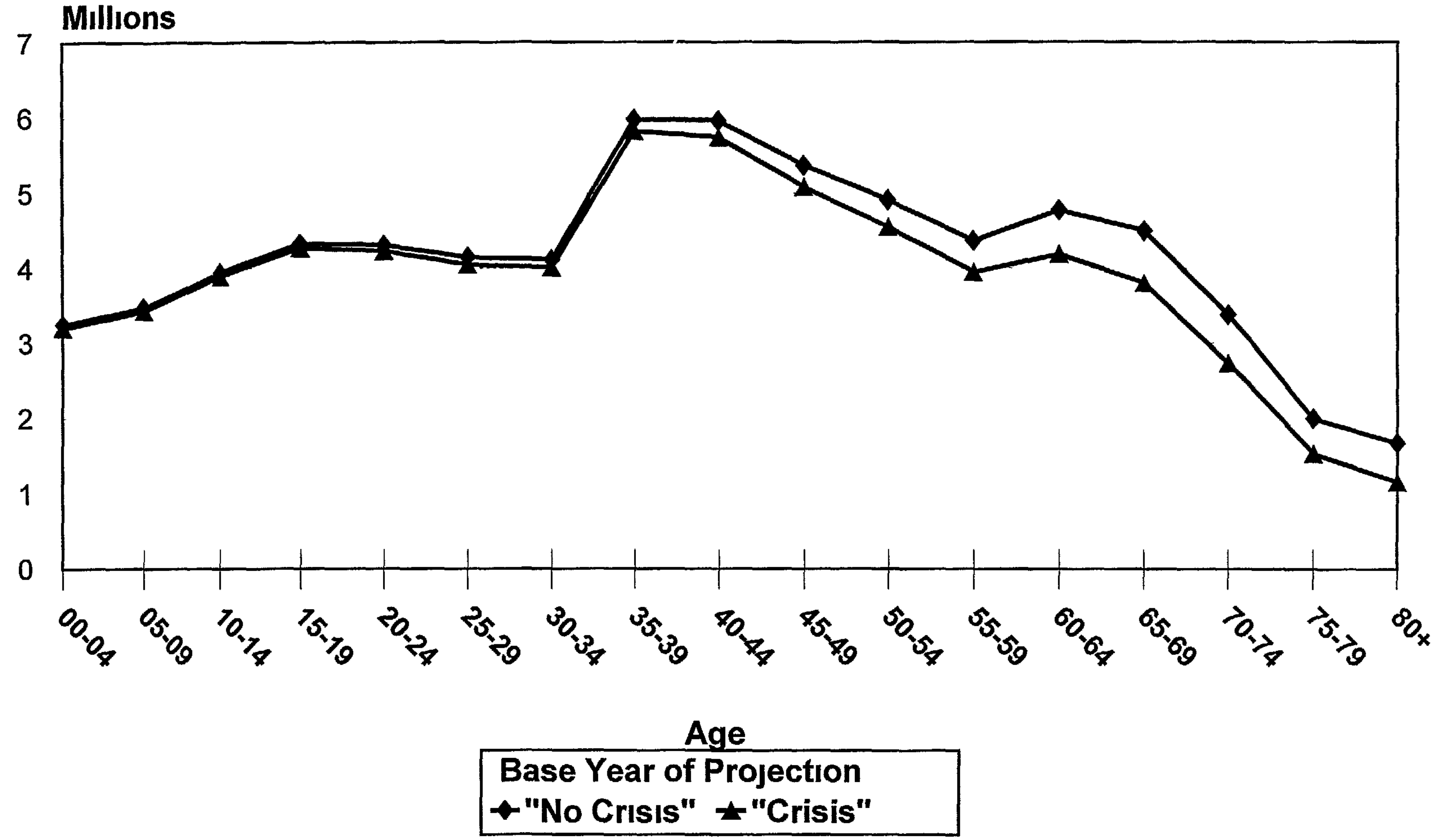


Figure 3

31

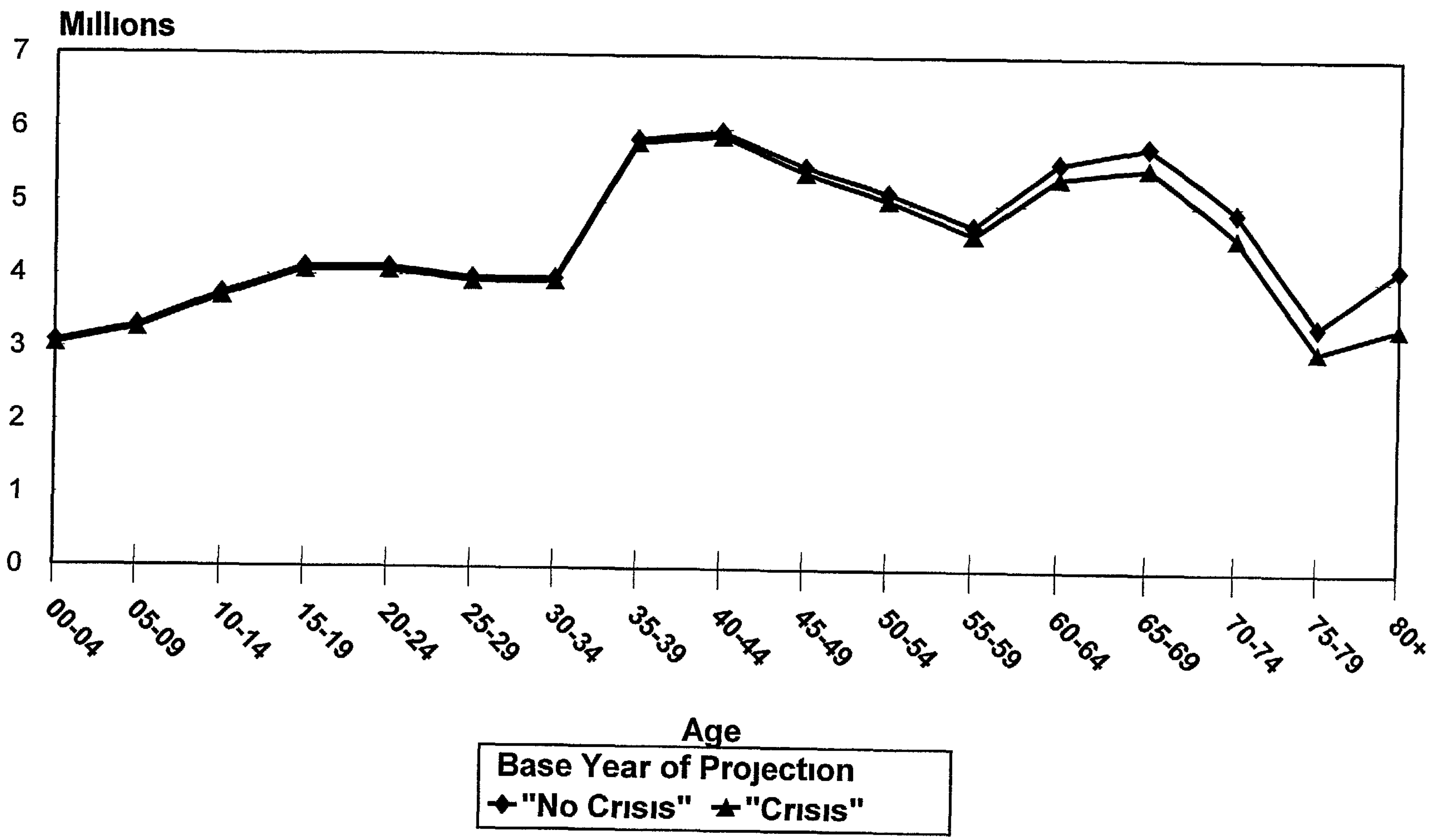
Comparison of Russian Male Population Age Structure in the Year 2025, given the 1990-1995 Mortality Crisis and in the Absence of the Crisis



Note The "No Crisis" projection assumes that life expectancy increases on the UN middle path between 1990 and 2025 and ignores the mortality crisis that took place during 1990 to 1995 The "Crisis" projection assumes that life expectancy increases on the UN middle path as well, but from 1995 onward and uses the actual 1995 population as its starting point

Figure 4a

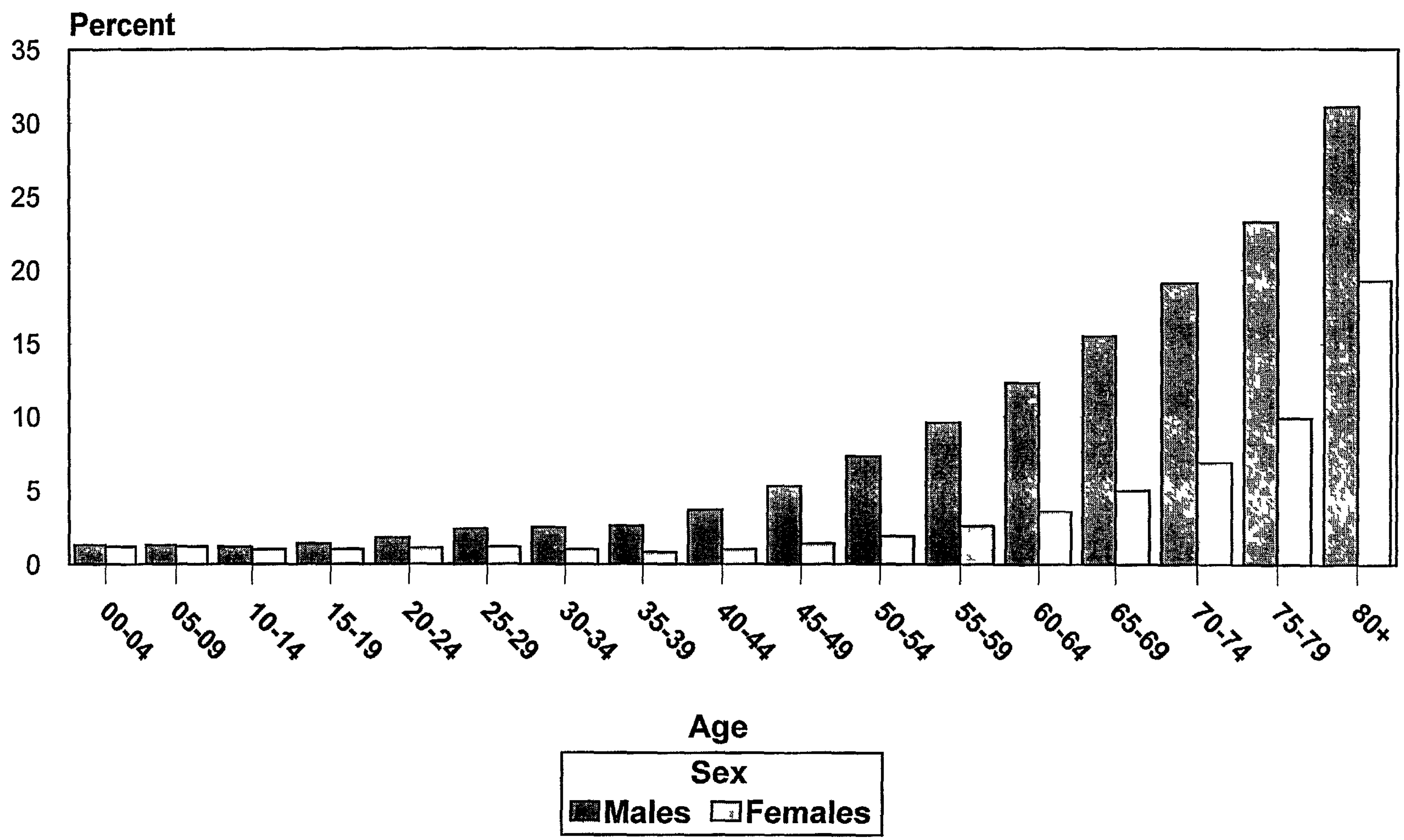
Comparison of Russian Female Population Age Structure in the Year 2025, given the 1990-1995 Mortality Crisis and in the Absence of the Crisis



Note The "No Crisis" projection assumes that life expectancy increases on the UN middle path between 1990 and 2025 and ignores the mortality crisis that took place during 1990 to 1995 The "Crisis" projection assumes that life expectancy increases on the UN middle path as well, but from 1995 onward and uses the actual 1995 population as its starting point

Figure 4b

Percentage Differences in the Russian Population Age Structure in the Year 2025, Given the 1990-1995 Mortality Crisis and in the Absence of the Crisis



Note The "No Crisis" projection assumes that life expectancy increases on the UN middle path between 1990 and 2025 and ignores the mortality crisis that took place during 1990 to 1995 The "Crisis" projection assumes that life expectancy increases on the UN middle path as well, but from 1995 onward and uses the actual 1995 population as its starting point

Figure 5

Male Dependency Ratios in the Year 2025, under Two Mortality Scenarios

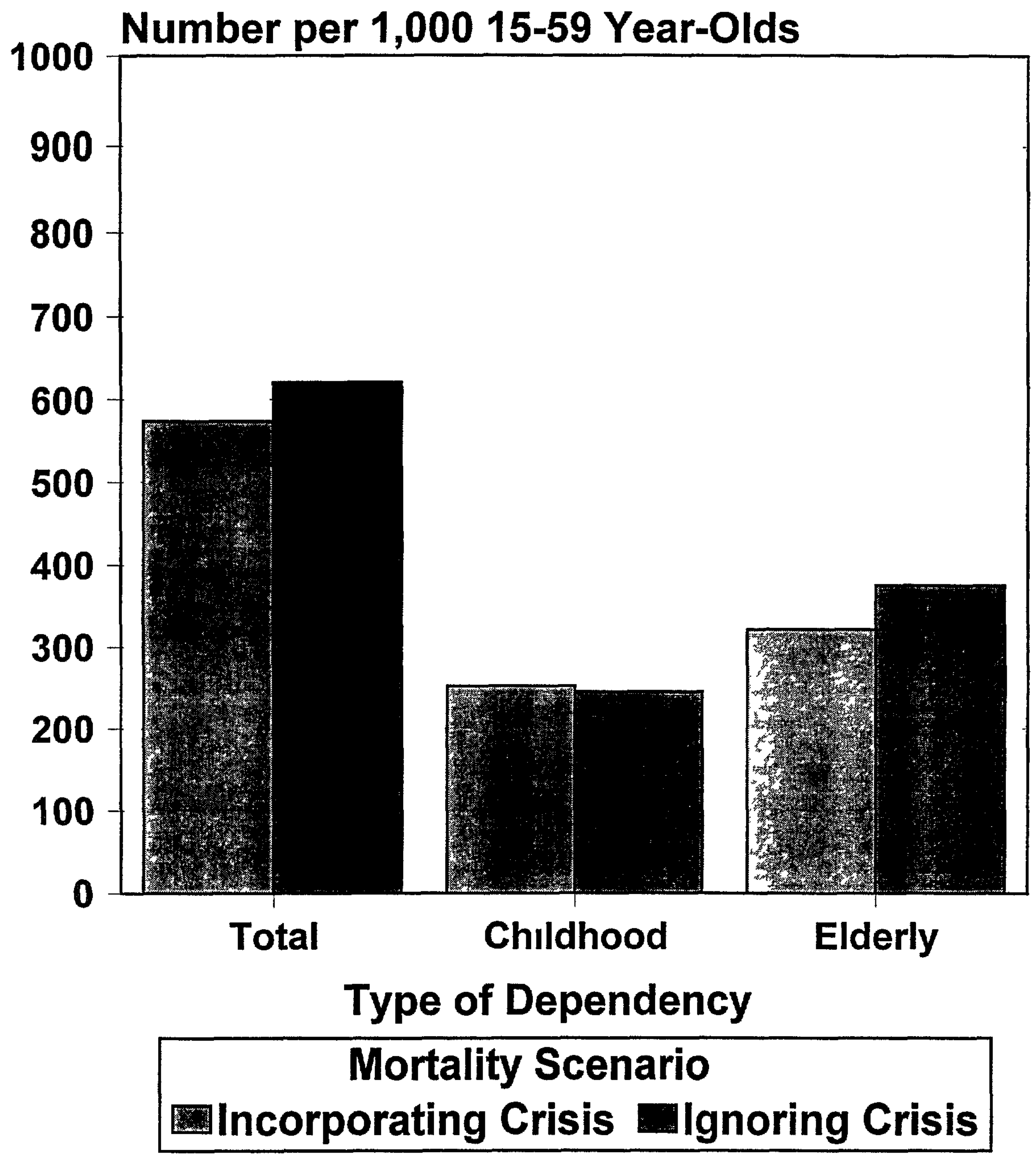


Figure 6a

35

Male Dependency Ratios in the Year 2025, under Two Mortality Scenarios

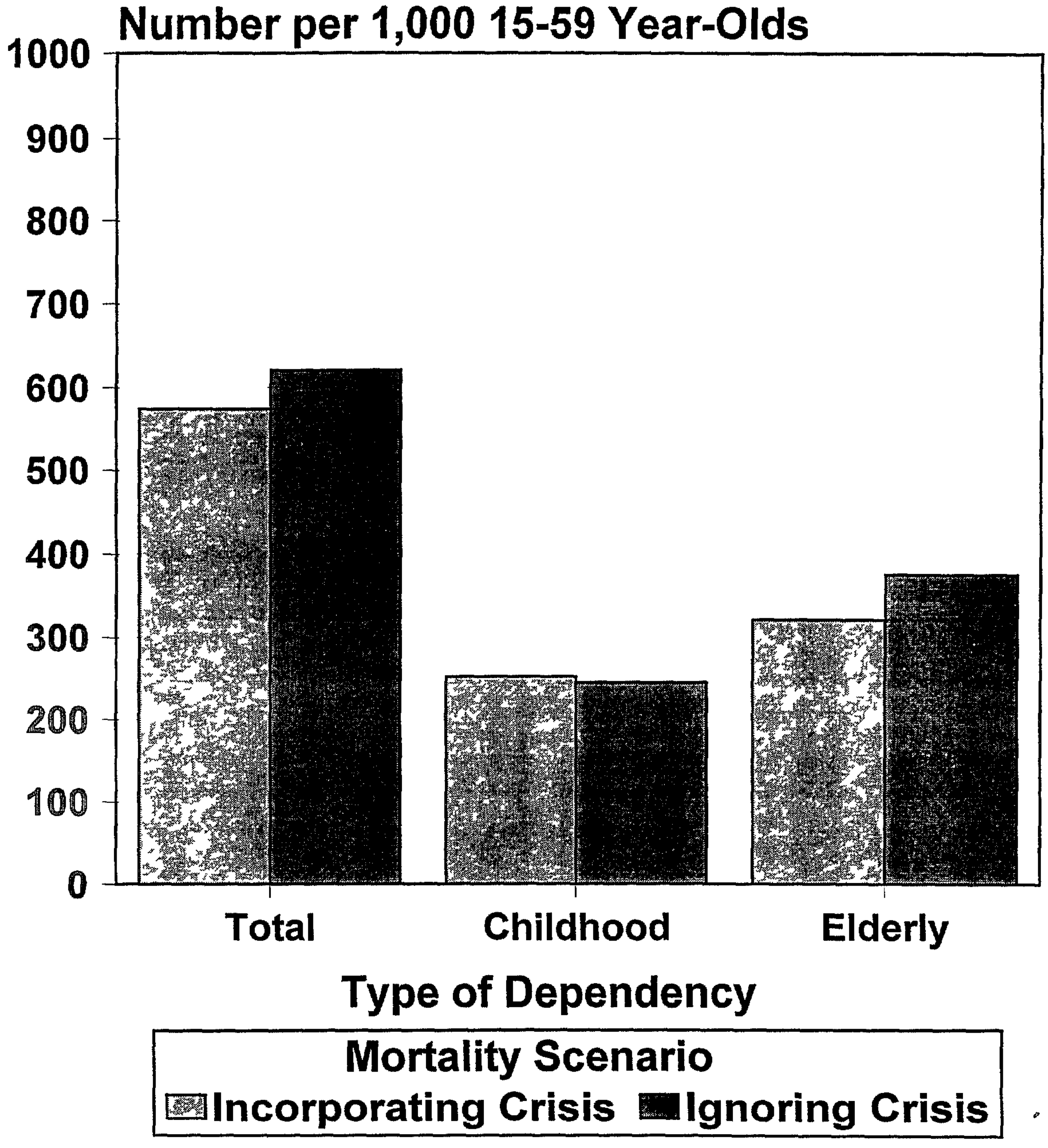


Figure 6a

Female Dependency Ratios in the Year 2025, under Two Mortality Scenarios

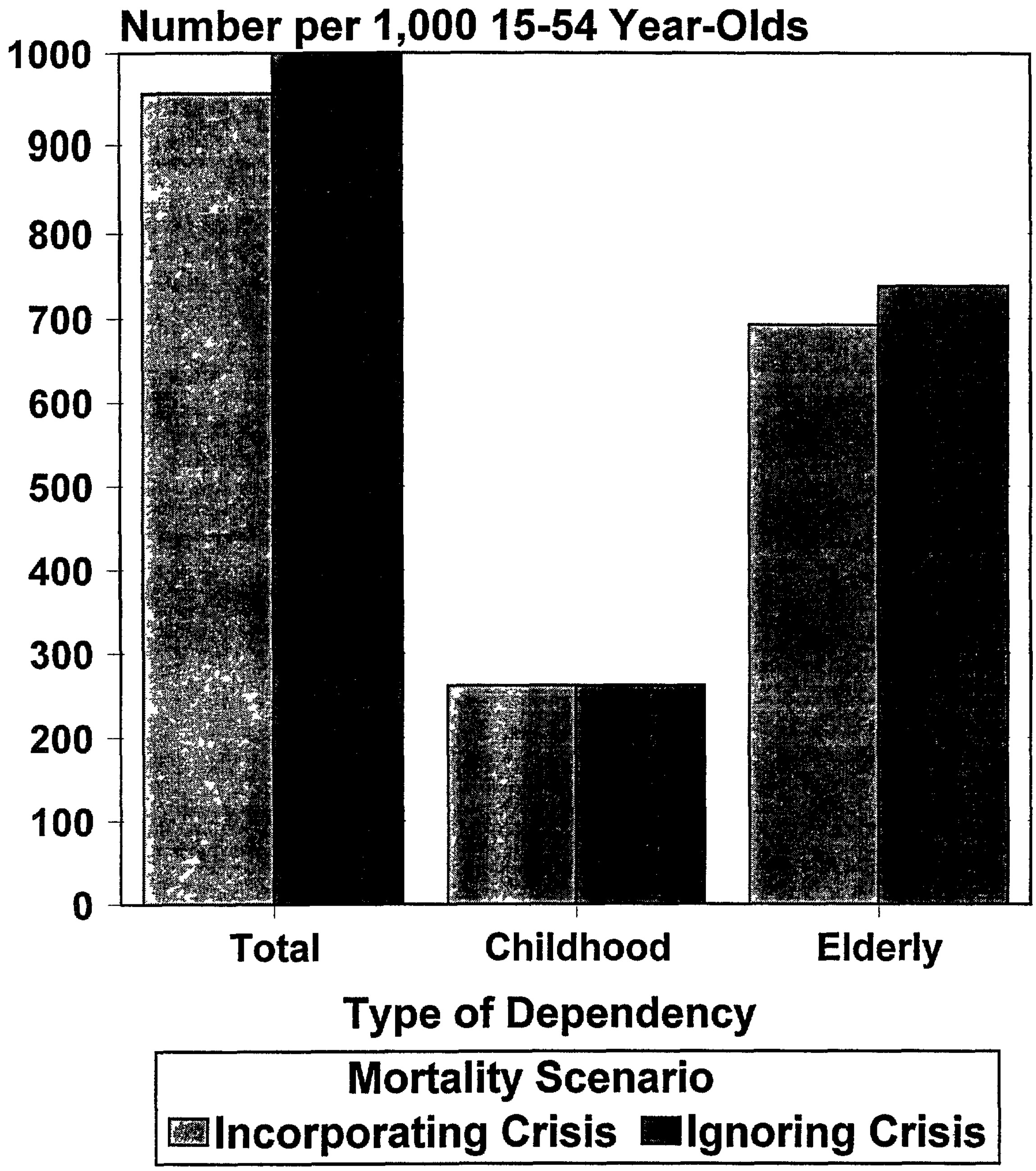
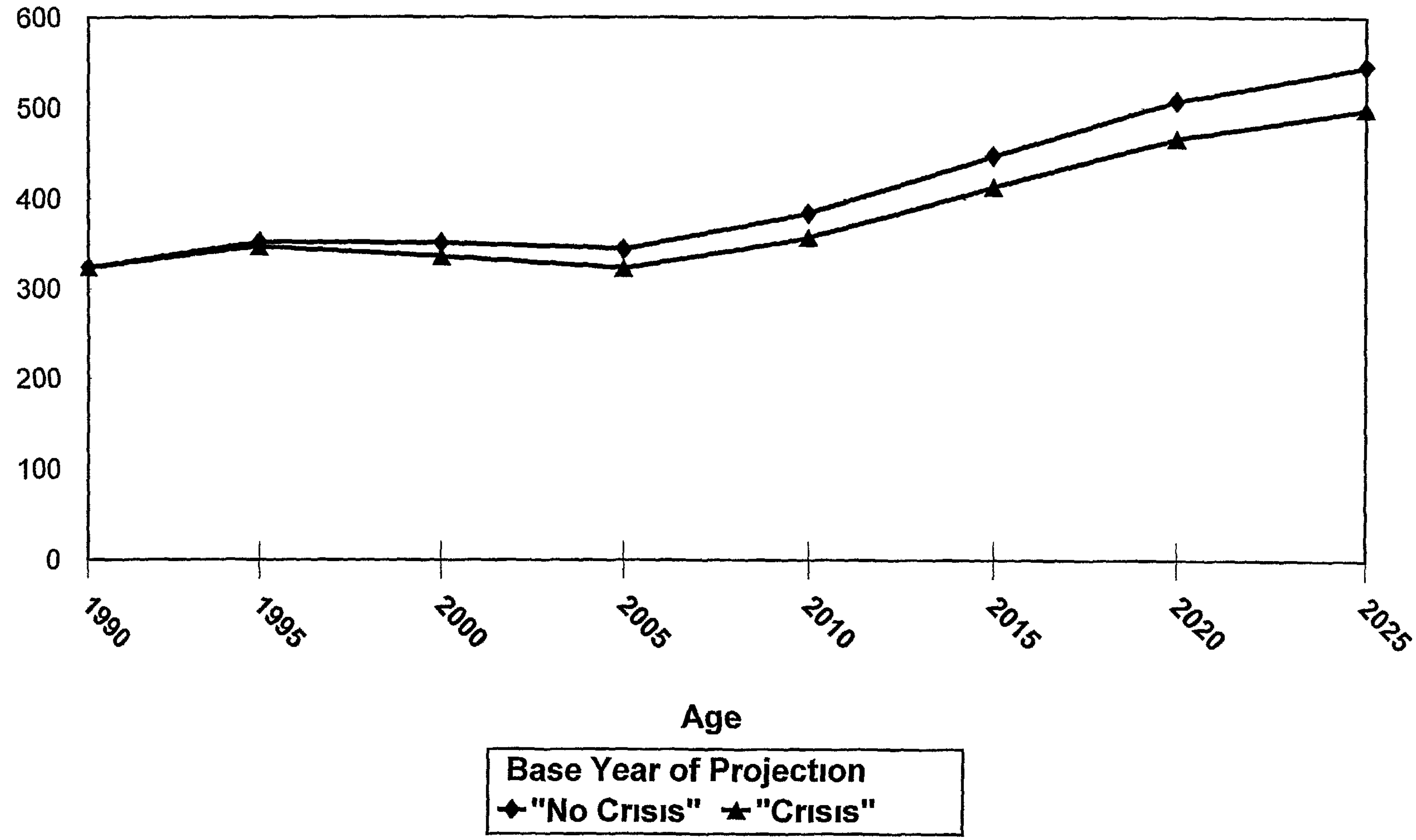


Figure 6b

Elderly Dependency Ratios for Both Sexes Combined, Given the 1990-1995 Mortality Crisis and in the Absence of the Crisis, 1990-2025



Note The "No Crisis" projection assumes that life expectancy increases on the UN middle path between 1990 and 2025 and ignores the mortality crisis that took place during 1990 to 1995 The "Crisis" projection assumes that life expectancy increases on the UN middle path as well, but from 1995 onward and uses the actual 1995 population as its starting point

Figure 6c

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Sex Ratios in the Year 2025, under Two Mortality Scenarios

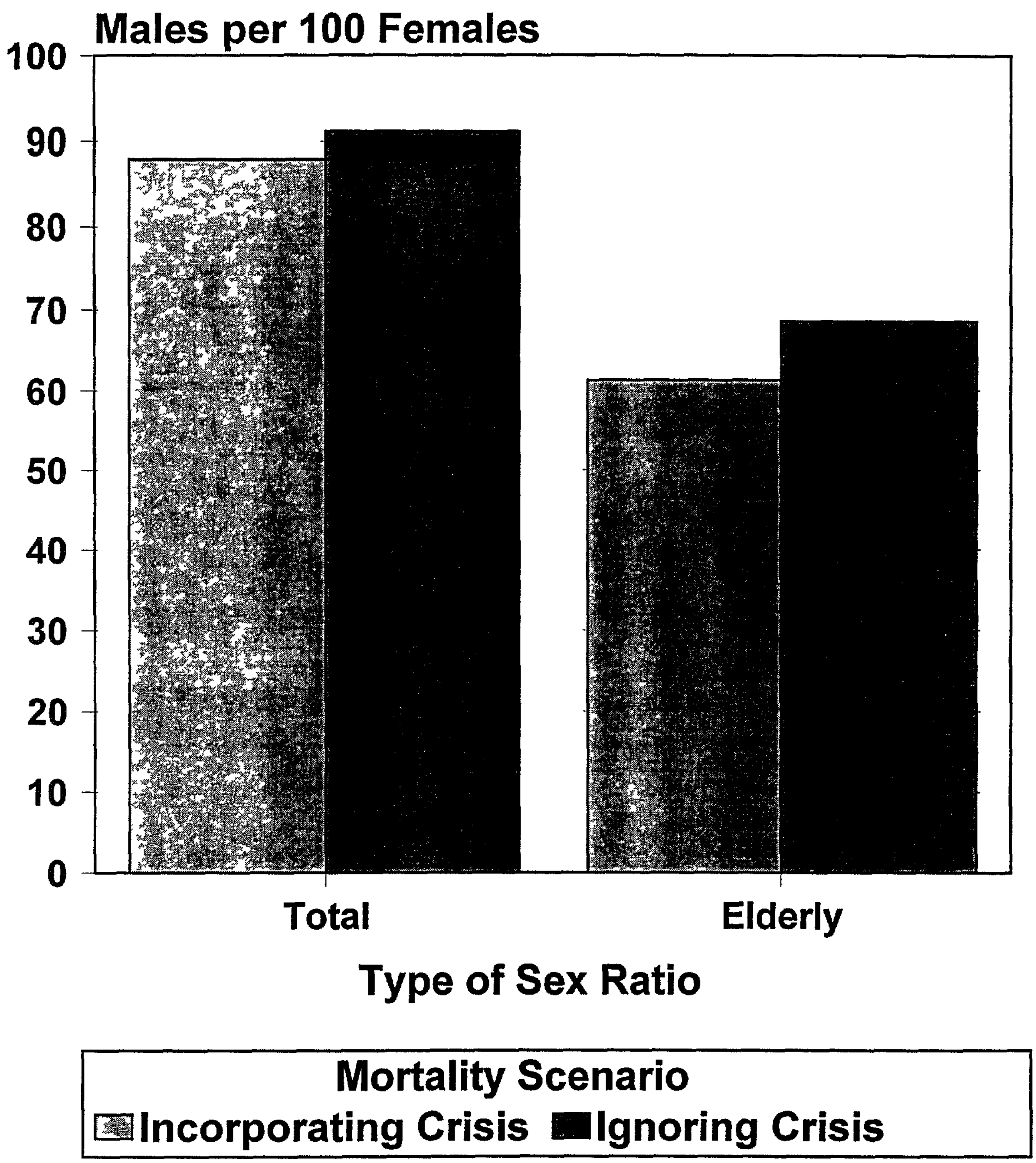

Figure 7

Table 1

Life Expectancies at Birth in Alternative Model Life Tables Corresponding to Different Age-Specific Probabilities of Dying in Russia During 1990-95

AGE GROUP	UNITED NATIONS MODELS					COALE-DEMENY MODELS			
	Latin Am	**Chilean**	**So Asian**	**Far East**	**General**	**West**	**North**	**East**	**South**
0	76 7	76 2	77 2	69 6	74 6	71 7	73 2	72 2	78 3
1	76 3	70 7	77 0	68 7	73 4	70 0	72 7	68 7	73 8
5	70 8	63 9	70 3	64 6	68 4	68 4	71 9	66 1	66 7
10	67 3	63 1	63 9	64 6	66 1	67 3	70 5	65 6	65 6
15	59 4	57 2	51 6	58 9	59 1	62 0	66 5	60 2	57 8
20	57 0	55 2	43 6	56 6	56 1	58 8	63 3	56 7	55 7
25	54 9	54 6	41 8	54 9	53 9	55 4	58 7	51 4	51 5
30	52 0	53 8	40 0	53 4	51 9	52 6	53 8	47 0	47 9
35	50 2	52 9	39 7	53 5	50 8	50 7	49 8	45 0	44 1
40	46 9	51 4	39 0	53 7	49 2	48 3	45 7	42 2	40 5
45	44 0	49 7	38 7	53 9	47 9	45 3	41 8	39 8	36 4
50	39 5	47 2	39 0	55 1	46 3	43 4	38 3	36 9	33 6
55	40 2	48 8	41 9	57 2	48 2	44 2	38 7	39 2	35 5
60	36 3	47 5	43 4	59 5	47 7	43 8	37 5	38 4	36 8
65	42 1	51 8	49 1	63 1	53 0	48 1	41 5	46 9	42 7
70	45 2	53 6	52 7	64 7	55 8	53 5	46 3	54 9	50 5
75	42 5	50 7	49 3	63 5	54 2	57 0	49 0	60 1	57 5

Source Authors' calculations using MortPak Lite

Table 2

Assumptions Regarding Mortality Improvement, 1990-2025

Period	Trajectories of mortality improvement, ignoring the 1990-95 crisis			Trajectories of mortality improvement incorporating the 1990-95 crisis		
	Fast	Middle	Slow	Fast	Middle	Slow
			Male life expectancy			
1985-1990	64 3	64 3	64 3	64.3	64 3	64 3
1990-1995	65 0	64 8	64 8	60 6	60 6	60 6
1995-2000	67 0	66 8	66 8	59 5	59 5	59 3
2000-2005	69 0	68 3	68 3	62 0	62 0	61 3
2005-2010	70 5	69 5	69 3	64 5	64 3	63 3
2010-2015	71 7	70 7	70 3	66 8	66 3	65 3
2015-2020	72 9	71 7	71 1	68 8	67 8	66 8
2020-2025	73 9	72 7	71 9	70 3	69 0	68 3
			Female life expectancy			
1985-1990	74 3	74 3	74 3	74 3	74 3	74 3
1990-1995	75 1	74 9	74 8	72.8	72 8	72 8
1995-2000	76 3	76 1	75 8	72 6	72 4	72 2
2000-2005	77 5	77 1	76 6	74 1	73 9	73 4
2005-2010	78 5	78 1	77 4	75 6	75 1	74 4
2010-2015	79 5	78 9	78 2	76 8	76 1	75 4
2015-2020	80 5	79 7	78 7	78 0	77 1	76 2
2020-2025	81 3	80 5	79 2	79 0	78 1	77 0

Note Observed values of life expectancy are represented in shaded cells Estimates for subsequent years are derived using the United Nations working model for mortality improvement (United Nations World Population Prospects The 1998 Revision (1998), Table 45) in conjunction with observed values for either 1990 or 1995, as appropriate

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Table 3

Size of Male and Female Population in 2025, Under Two Mortality Scenarios

	Observed 1990 Population (in mil)		2025 Population Incorporating Crisis (in mil)	2025 Population Ignoring Crisis (in mil)	Percent Decrease Due to Crisis
Males	69 44	UN Fast	66 23	71 39	7.2
		UN Middle	65 62	70 45	6.9
		UN Slow	64 88	70 03	7.3
Females	78 85	UN Fast	75 28	77 89	3.4
		UN Middle	74 68	77 33	3.4
		UN Slow	73 97	76 54	3.4

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Table 4

Age-specific sex ratios (males per female), 1995-2025 (based on middle trajectory of mortality improvement)

	1990	1995	2000	2005	2010	2015	2020	2025
Ignoring the 1990-95 crisis								
15-19	1 035	1 028	1 031	1 040	1 048	1 049	1 050	1 051
20-24	1 051	1 029	1 023	1 027	1 036	1 045	1 047	1 048
25-29	1 032	1 041	1 021	1 017	1 021	1 031	1 040	1 043
30-34	1 015	1 019	1 030	1 013	1 009	1 015	1 026	1 035
35-39	0 994	0 998	1 006	1 018	1 003	1 001	1 007	1 019
40-44	0 970	0 972	0 979	0 990	1 004	0 991	0 990	0 998
45-49	0 910	0 940	0 946	0 957	0 970	0 986	0 975	0 976
Incorporating the 1990-95 crisis								
15-19	1 035	1 026	1 028	1 036	1 040	1 040	1 044	1 047
20-24	1 051	1 025	1 016	1 019	1 029	1 035	1 036	1 040
25-29	1 032	1 035	1 008	1 002	1 008	1 020	1 028	1 030
30-34	1 015	1 012	1 012	0 991	0 989	0 998	1 011	1 020
35-39	0 994	0 989	0 983	0 989	0 973	0 974	0 986	1 001
40-44	0 970	0 960	0 952	0 953	0 964	0 954	0 958	0 971
45-49	0 910	0 926	0 913	0 912	0 921	0 938	0 931	0 938